

Exascale Computing Project (ECP) Update

Presented to
ASCAC

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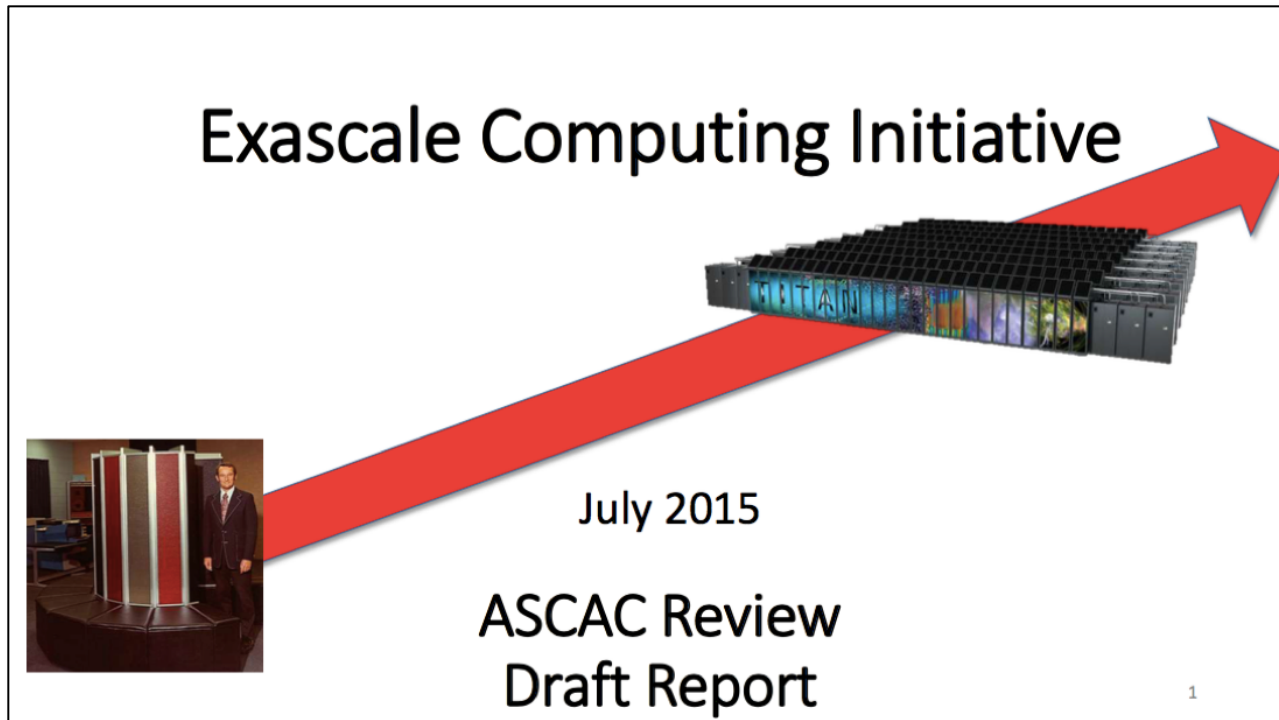
Washington, D.C.

April 4, 2016



EXASCALE COMPUTING PROJECT

ECP is in the process of making the transition from an initiative to a formal DOE project



Quite a bit has happened since July last year...

ECP mission need

On July 29, 2015 the President established the National Strategic Computing Initiative (NSCI) to maximize the benefits of HPC for US economic competitiveness and scientific discovery.

DOE is a lead agency within NSCI with the responsibility that the DOE Office of Science and DOE National Nuclear Security Administration will execute a joint program focused on advanced simulation through a **capable** exascale computing program emphasizing sustained performance on relevant applications.

In 2015, ASCAC made the following recommendations to the then nascent ECI

- 1. Develop a detailed management and execution plan that defines clear responsibilities and decision-making authority to manage resources, risks, and dependencies appropriately across vendors, DOE laboratories, and other participants.**
- 2. Unlike other elements of the hardware/software ecosystem, application performance and stability are mission critical, necessitating continued focus on hardware/software co-design to meet application needs.**
- 3. As part of the execution plan, clearly distinguish essential system attributes (e.g., sustained performance levels) from aspirational ones (e.g., specific energy consumption goals) and focus effort accordingly.**
- 4. Mitigate software risks by developing evolutionary alternatives to more innovative, but risky alternatives.**
- 5. Remain cognizant of the need for the ECI to support both data intensive and computation intensive workloads.**
- 6. Given the scope, complexity, and potential impact of the ECI, conduct periodic external reviews by a carefully constituted advisory board.**
- 7. Where appropriate, work with other federal research agencies and international partners on workforce development and long-term research needs, while not creating dependences that could delay or imperil the execution plan.**

The ECP is a lab-led *Project* transitioning from the DOE exascale research activities

- DOE has been funding research related to exascale challenges for 5+ years
- The Exascale Computing Project (ECP) is being launched as a joint SC/NNSA partnership using DOE's formal project management processes
- The ECP is managed by DOE laboratories following DOE Order 413.3B

Programmatic components of the ECP

- It is a partnership between SC and NNSA, addressing science and national security missions
 - Relies on investments by SC/ASCR and NNSA/ASC
 - NNSA/ASC Advanced Technology Development and Mitigation (ATDM) supports activities for the delivery of exascale applications, software, and technology
- ECP does not procure exascale systems
 - ECP includes only activities required for the delivery of the exascale computing capability (procurements of exascale systems will follow SC and NNSA processes and timelines)
- Relationship of the ECP to the National Strategic Computing Initiative
 - On July 29, 2015, an executive order established the National Strategic Computing Initiative (NSCI) to ensure a coordinated Federal strategy in HPC research, development, and deployment.
 - DOE, along with the DoD and NSF, co-leads the NSCI. Within DOE, SC and NNSA execute the ECP, which is the primary DOE contribution to the NSCI.



ECP Goals

- Develop a broad set of modeling and simulation applications that meet the requirements of the scientific, engineering, and nuclear security programs of the Department of Energy and the NNSA
- Develop a productive exascale capability in the US by 2023, including the required software and hardware technologies
- Prepare two or more DOE Office of Science and NNSA facilities to house this capability
- Maximize the benefits of HPC for US economic competitiveness and scientific discovery

ECP goals will be tracked and accomplished via familiar DOE processes

- ECP will fund and manage work at the national laboratories, industry (including medium and small businesses), and universities
- In most cases ECP will provide incremental funding to teams that already have a funding base
 - Build on existing activities
 - “incremental” does not mean small
- There is a formal solicitation and selection process
- There are major deliverables and various reviews of major milestones and deliverables

ECP Technical Approach

ECP will pursue a ten-year plan structured into four focus areas:

- **Application Development** deliver scalable science and mission performance on a suite of ECP applications that are ready for efficient execution on the ECP exascale systems.
- **Software Technology** enhance the software stack that DOE SC and NNSA applications rely on to meet the needs of exascale applications and evolve it to utilize efficiently exascale systems. Conduct R&D on tools and methods that enhance productivity and facilitate portability.
- **Hardware Technology** fund supercomputer vendors to do the research and development of hardware-architecture designs needed to build and support the exascale systems.
- **Exascale Systems** fund testbeds, advanced system engineering development (NRE) by the vendors, incremental site preparation, and cost of system expansion needed to acquire capable exascale systems.

Current ECP status

- Project office established at ORNL
- Project team leadership selected
- Project scope determined and detailed WBS created
- Successfully completed an Independent Cost Review and an Independent Design Review
- Solicited proposals in applications, co-design centers, and software technology for exascale
- Vendor information meeting for hardware technology April 6, 2016
 - draft RFP for PathForward (Hardware Technology R&D) is online
- Awaiting CD-0 approval
- Preparing for CD-1/3a review in May

ECP Laboratory Team

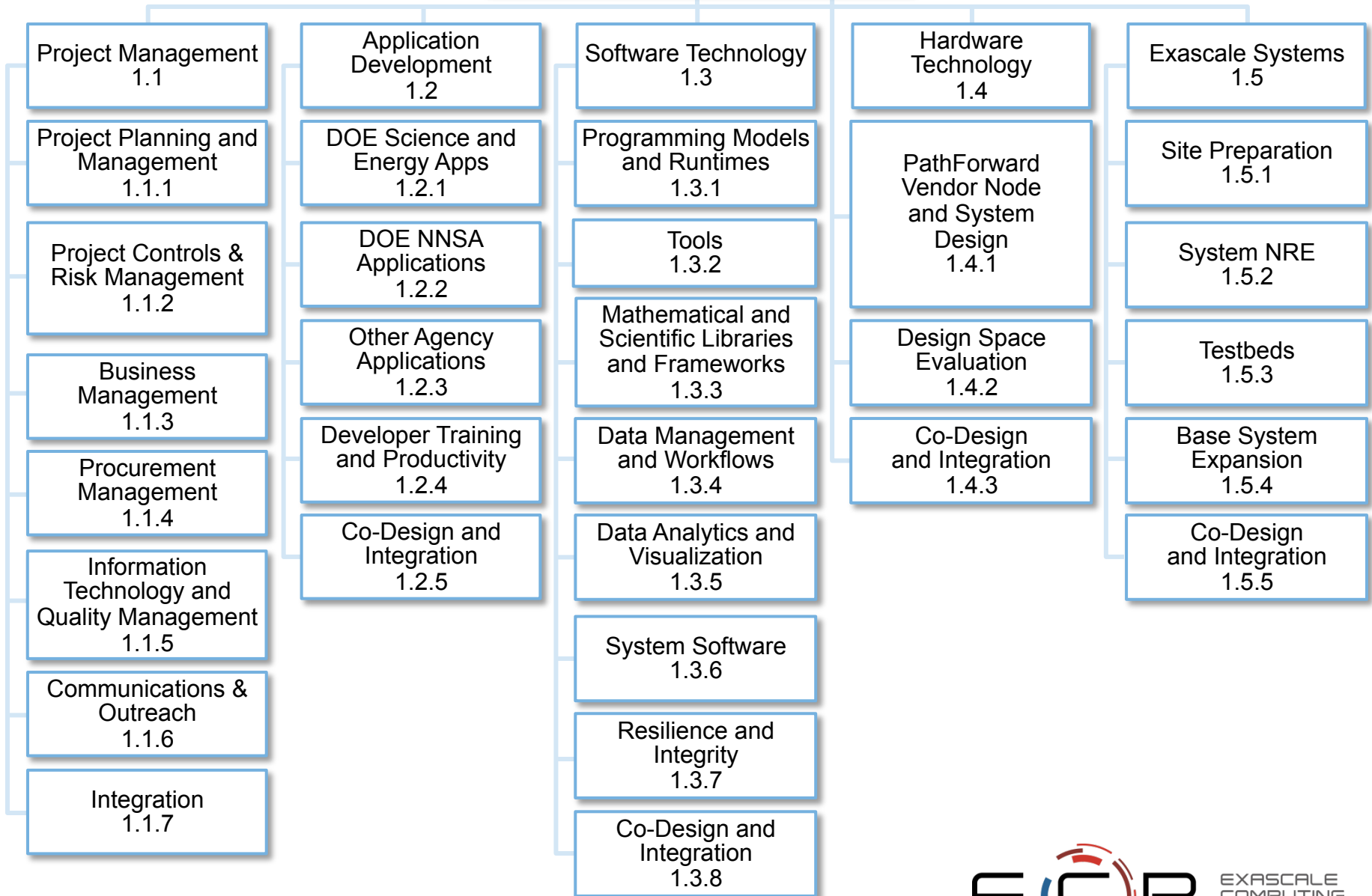
Project Director Deputy	Paul Messina, ANL Stephen Lee, LANL
Project Management Director	Kathlyn Boudwin, ORNL
Applications Development Director Deputy	Doug Kothe, ORNL Bert Still, LLNL
Software Technology Director Deputy	Rajeev Thakur, ANL Pat McCormick, LANL
Hardware Technology Director Deputy	Jim Ang, SNL John Shalf, LBNL
Exascale Systems Director Deputy	Terri Quinn, LLNL Susan Coghlan, ANL
CTO	Al Geist, ORNL
Integration Manager	Julia White, ORNL

ECP Scope is based on Mission Needs and Requirements

- Scope was determined based on
 - Breadth of the mission-critical DOE and NNSA applications
 - Historical and current software requirements of DOE and NNSA applications
 - Input on future needs from 133 DOE and NNSA lab responses to the applications RFI
 - Reports of DOE and NNSA workshops on application and software needs for exascale
 - Reports of workshops and analyses of hardware requirements
 - Analyses of computing technology trends
 - Identifying gaps in vendor product plans for DOE mission applications
 - Experiences from the NNSA ASCI program

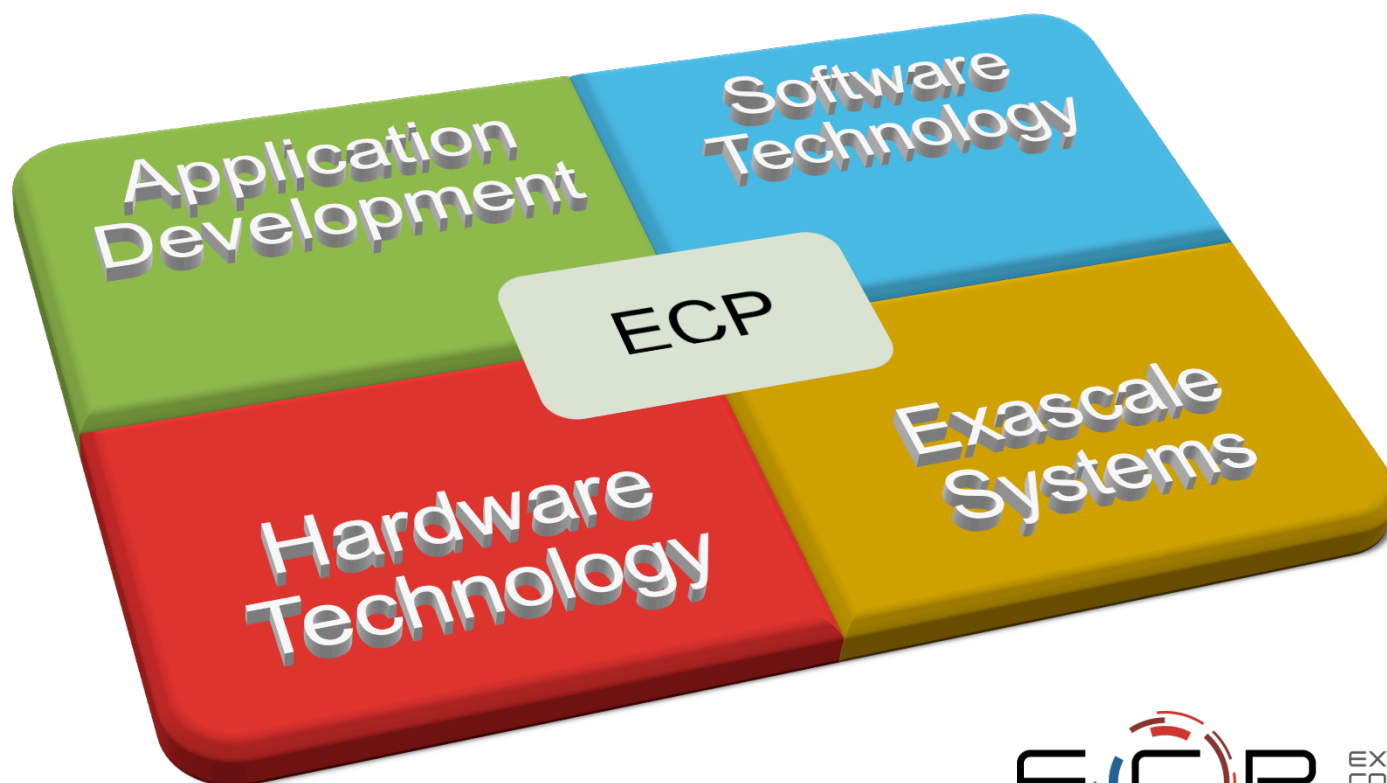
ECP WBS

Exascale Computing Project 1.



ECP Holistic Structure

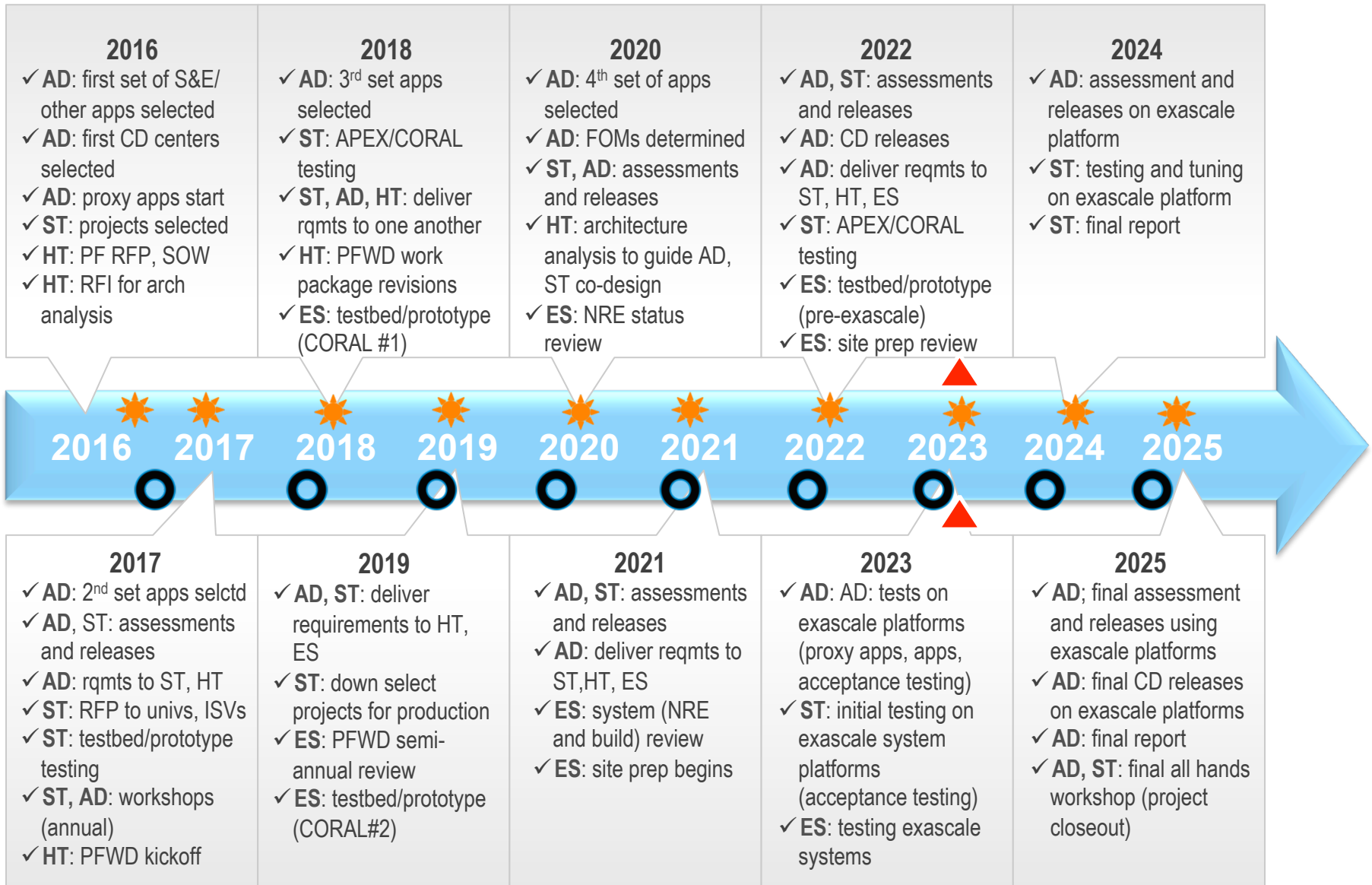
Capable exascale computing requires close coupling and coordination of key development and technology R&D areas.



ECP Integration/Co-Design is an essential function of the leadership team

- ECP leadership team members participate in evaluation of all major decisions
- Focus area directors will work closely to ensure that
 - the ECP applications will be ready to use the exascale systems productively
 - the supporting software will meet the needs of the applications and run effectively and efficiently on the exascale architectures
 - the architectures and the hardware technologies of the exascale systems are designed to support a broad range of ECP application computational characteristic

ECP has a detailed integrated timeline

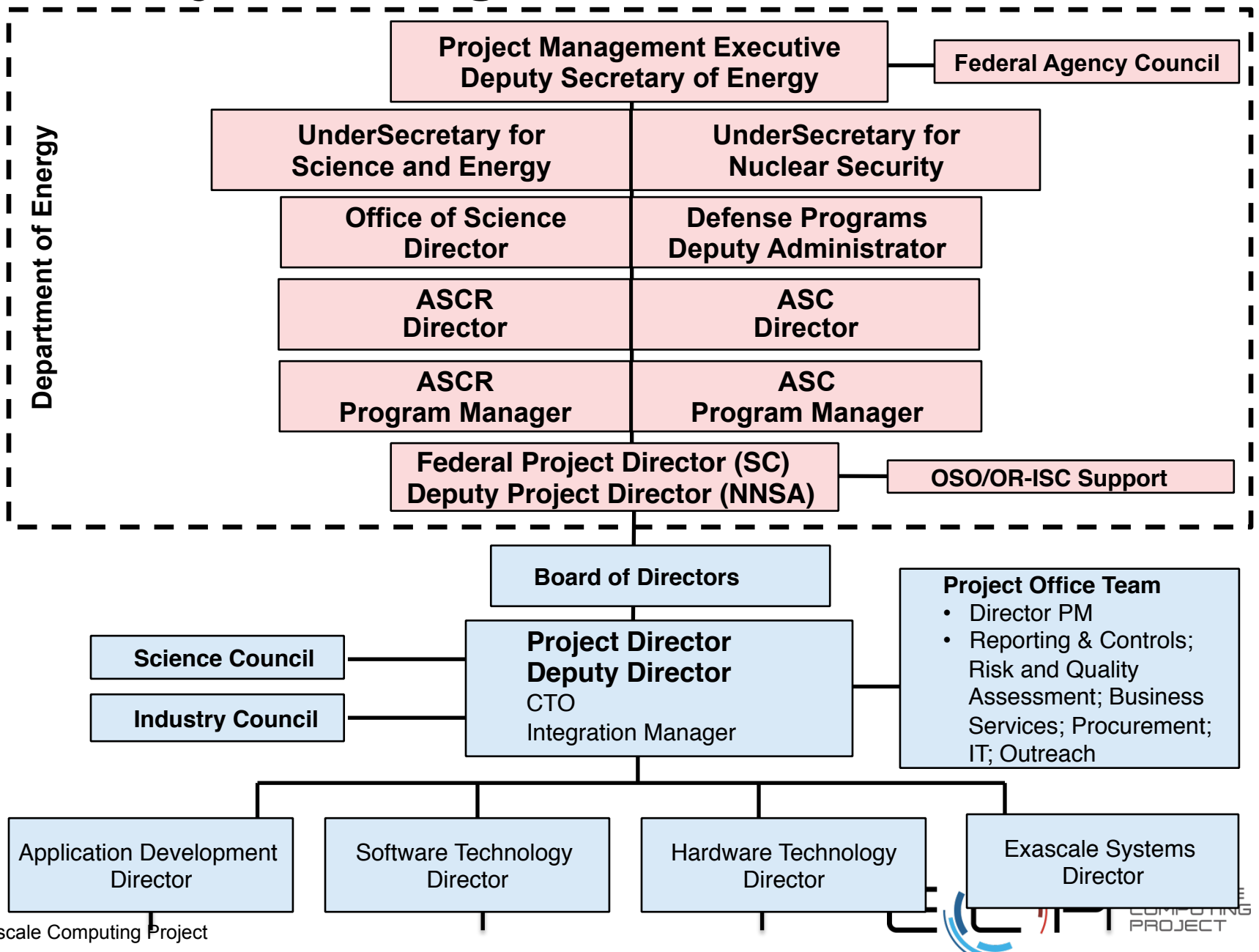


▲ exascale systems

● ECP all-hands meetings

★ Cross-Focus Area workshops or reviews

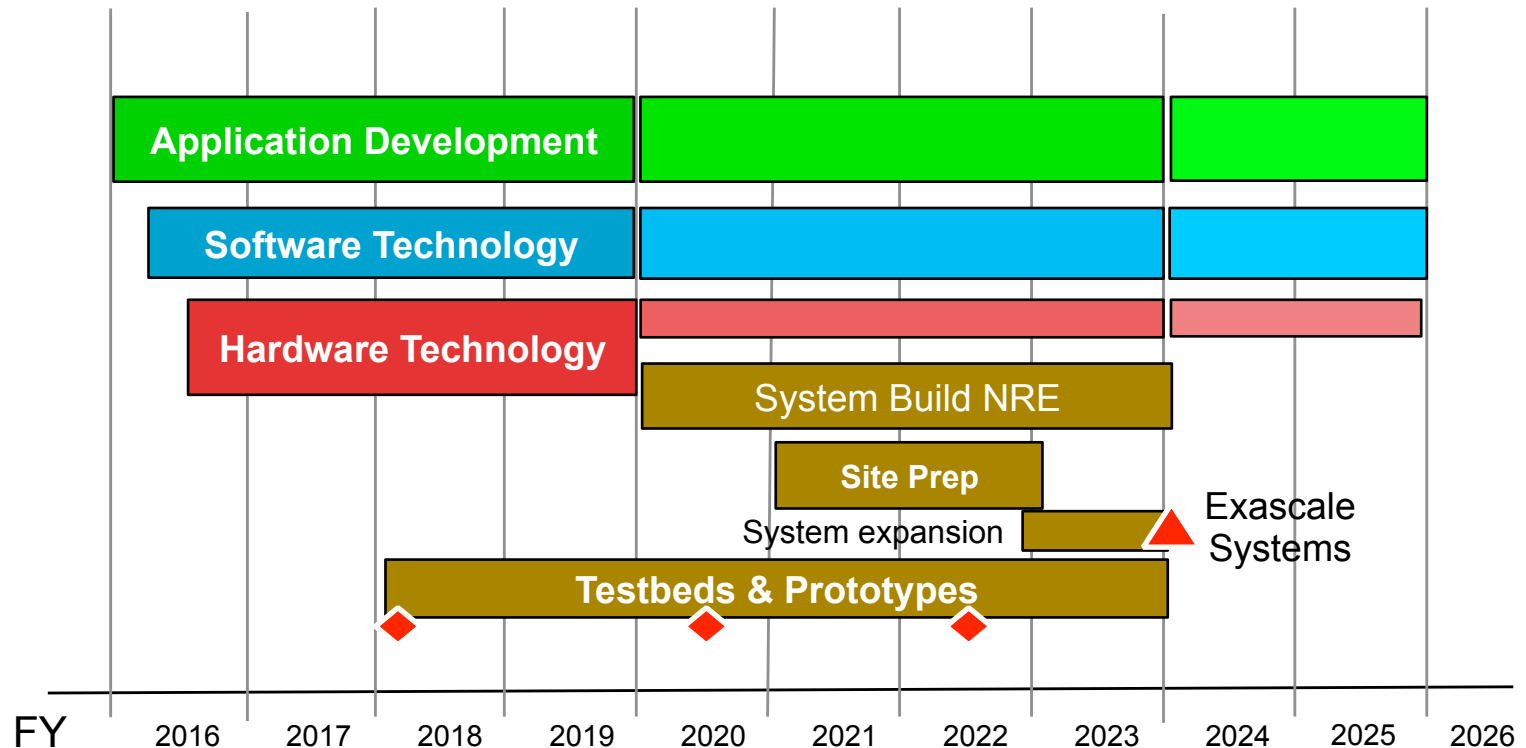
ECP Project Management Structure



ECP Timeline

The Project has three phases:

- Phase 1 – R&D before DOE facilities exascale systems RFP in 2019
- Phase 2 – Exascale architectures and NRE are known. Targeted development
- Phase 3 – Exascale systems delivered. Meet Mission Challenges



ECP activity solicitation and selection process

- The call, review, and selection process for ECP activities is generally:
 - Request for Information (RFI): 2 – 3 page white papers,
 - Review against published criteria,
 - Down selection to a reduced number for Request for Proposal (RFP),
 - Review against published criteria, and
 - Selection
- Selection criteria include quality and makeup of the team, relevance to exascale, match to mission needs, technical feasibility.
- Process steps, RFIs, RFPs, and criteria are tuned as appropriate for the technical project under consideration and target (academia, industry).
- The ECP focus area leaders select teams of subject matter expert reviewers.
 - Review results inform the decision process, which is finalized within the ECP to ensure integration across the project.

ECP has developed a detailed set of technical risks

- Inability of applications to achieve their science goals
 - Vendor issues could result in project delays, technical challenges or financial losses
 - Inability to inject needed software technologies into production
 - Unavailability of math libraries and software frameworks or insufficient application integrity for adequate throughput and productivity
- *Above are top technical risks; over 70 risks currently in Risk Register*

ECP is off to a strong start

- ✓ Develop a detailed management and execution plan that defines clear responsibilities and decision-making authority to manage resources, risks, and dependencies appropriately across vendors, DOE laboratories, and other participants. **Mostly developed (pending MOA among Labs & CD-1/3a review)**
- ✓ Unlike other elements of the hardware/software ecosystem, application performance and stability are mission critical, necessitating continued focus on hardware/software co-design to meet application needs. **Part of the ECP WBS**
- ✓ As part of the execution plan, clearly distinguish essential system attributes (e.g., sustained performance levels) from aspirational ones (e.g., specific energy consumption goals) and focus effort accordingly. **Planned as part of project execution**
- ✓ Mitigate software risks by developing evolutionary alternatives to more innovative, but risky alternatives. **Planning focuses on evolution selectively, including innovation**
- ✓ Remain cognizant of the need for the ECI to support both data intensive and computation intensive workloads. **Planned as part of project execution**
- ✓ Given the scope, complexity, and potential impact of the ECI, conduct periodic external reviews by a carefully constituted advisory board. **Planned in the ECP PEP**
- ✓ Where appropriate, work with other federal research agencies and international partners on workforce development and long-term research needs, while not creating dependences that could delay or imperil the execution plan. **Such considerations are included in ECP planning and programmatic discussions**

Questions?



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